CHAMBER FOR GAS DETECTOR

Field Of The Invention

The invention pertains to gas detectors. More particularly, the invention pertains to gas detectors having a reference chamber, a sensing chamber and a common source of radiation.

Background Of The Invention

Non-dispersive infrared (NDIR) gas detectors are known for sensing the presence and concentration of various gases. Many known NDIR-type detectors are more in the nature of laboratory instruments than relatively small, rugged and convenient sensors for use in the field. As a result, many of the known detectors have suffered from complexity and relatively high cost.

Airborne contaminants such as particulate matter or water vapor can adversely affect detector outputs. Filtering is known to exclude particular matter. Filtering, however, may not exclude water vapor. Other known NDIR-type detectors have attempted to address environmental conditions, such as condensation of water vapor in the gas being sampled by heating the sample chamber electrically. Such heaters and their power supplies result in added bulk, weight and cost in the respective detectors.

There thus continues to be a need for NDIR-type detectors which do not require either electrical heating, or large amounts of space, electromechanical choppers and the like, or, complex processing circuitry. Preferably, such chambers could be inexpensive to manufacture, and require little or no adjustment or field maintenance.

Brief Description Of The Drawings

Fig. 1 is an over-all view of a detector in accordance with the present invention, partly broken away;

Fig. 2 is a perspective view of a portion of the detector of Fig. 1;

Fig. 3 is an end elevational of the housing of Fig. 2;

Fig. 4 is a top plan view of the chamber of Fig. 2;

Fig. 5 is a sectional view taken along plane 5-5 of Fig. 3;

Fig. 6 is a sectional view taken along plane 6-6 of Fig. 3; and

Fig. 7 is an enlarged view of a portion of the chamber of Fig. 6.

Detailed Description Of The Embodiments

While embodiments of this invention can take many different forms, specific embodiments thereof are shown in the drawings and will be described herein in detail with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the specific embodiment illustrated.

A gas detector in accordance with the invention can be fabricated as a smaller, light weight, stand alone portable device that has no adjustments. Such detectors can, alternately, be part of a larger monitoring system.

A sensor design which embodies the invention is suitable for use in NDIR-type gas detectors. This structure includes a sensing and a reference chamber that are open to each other. The reference chamber is a mirror image of the sensing chamber relative to a plane that passes between them.

The sensing chamber has a radiant energy sensor with a filter that passes the band of energy associated with the gas to be detected. The reference chamber has a radiant energy sensor with a filter that passes a band of energy not associated with the gas to be detected. An opening for lateral entry of the gas being monitored is preferably symmetrically located between the sensing and reference chambers.

The sensing and reference chambers each include a concave reflective surface such that substantially only one reflection of light occurs between an emitter and the associated sensor. The path length of the light rays is substantially similar.

One advantage of the reference chamber being a mirror image of the sensing chamber is that environmental conditions are likely to affect each chamber the same. For example, any water vapor in the gas sample can be expected to condense uniformly on the reflective surfaces, thus affecting performance of each chamber equally. Thus, compensation for such environmental conditions is more readily achieved. Further, each chamber has a similar concave reflective surface that focuses a substantial amount of the light rays to the associated sensor.

Fig. 1 illustrates detector 10 which has a housing 12. Housing 12 carries control circuits 16, which could be implemented in part with a processor and executable instructions. Housing 12 also carries housing 18 for sensing a concentration of a selected gas.

Display 20, driven by signals from control circuit 16 could display gas concentration, for example, parts per million or the like all without limitation. It will be understood that the characteristics of the display 20 are not a limitation of the present invention.

Housing 18 is formed with bounding side walls 18a, b, c, d which bound on interior region 18e. The side walls define a sensing chamber or portion indicated generally at 30a and a reference chamber or portion indicated generally at 30b. The sensing and reference chambers 30a, b are open to each other along a common plane P, see Fig. 3.

Plane P corresponds to plane 5-5 and is generally parallel to a direction of flow of gas into/out of detector 10.

Reference chamber 30b is a mirror image of sensing chamber 30a. A shared emitter 32 is located on the common plane P between the sensing and reference portions 30a, b. The housing 18 can be formed of a variety of

materials, including cured plastic resin, all without limitation of the present invention.

Sensors 34a and 34b are carried on side wall 18d. Each of the sensors 34a, b has associated therewith a respective optical filter 36a, b. The filter 36a passes a band of energy associated with the gas to be detected. The filter 36b passes a band of energy not associated with the gas to be detected. Sensors 34a, b and their respective filters 36a, b are symmetrically located relative to plane P and emitter 32.

The filter 36a for the sensing chamber 30a passes a wavelength(s) known to be absorbable by the gas(s) being used. Filter 30b, for reference chamber 30b passes a wavelength(s) not absorbed by the gas(s) being sensed.

Each of the chambers 30a, b also includes a curved concave reflector 38a, 38b. The reflector could be spherical or parabolic all without limitation of the present invention. Other curved surfaces could also be used.

Radiant energy emitted from emitter 32 is equally incident upon reflector 38a, 38b after passing through the respective sensing chamber 30a or reference chamber 30b. On reflection off of the respective surfaces 38a, b, the radiant energy passes through respective filter 36a, b and is incident upon respective sensor 34a, b which converts same to a corresponding electrical signal. Those signals are in turn coupled to control circuit 16.

Representative types of gases suitable for being sensed using gas sensor 18 include hydrocarbons such as carbon monoxide, carbon dioxide, combustible gases such methane, ethane and the like as well as water vapor. It will be understood that the gas being sensed is not a limitation of the invention.

Emitter 32 is selected to have a radiant energy output of a wavelength absorbable by the type of gas to be sensed. For example, emitters having wave lengths in the range of 3 to 5 microns are suitable for sensing hydrocarbons such as carbon monoxide or carbon dioxide. Other wave

lengths would be used, as would be understood by those of skill in the art, for sensing different gases.

The emitter 32 could be implemented using a light bulb, a light emitting diode, a laser diode or the like all without limitation. It will also be understood that the particular emitter of choice in a given gas sensor is not a limitation of the invention.

It will also be understood that the bounded open region 18e of housing 18 through which the gas flow passes could be closed with one or more gas receiving filters F, such as a semi-permeable membrane. Use of a filter such as a membrane reduces or limits the velocity of gas flow through the housing 18 such that movement therein is by diffusion only. Further, use of a filter excludes undesirable incident particulate matter. It will be understood that a variety of filter configurations could be used without departing from the spirit and scope of the present invention.

The gas sensor 18 has a structure which is particularly advantageous in that there is by and large only a single reflection of radiant energy emitted at emitter 32 before being incident on one of the respective sensors 34a, b. This single reflection takes place at the respective reflector 38a, b. As a result, the distance traversed by the radiant energy in both the sensing chamber and the reference chamber 38a, b is substantially identical in both instances. The structure is also advantageous in that the concave reflective surfaces 38a, b focus a substantial portion of the incident radiant energy onto the respective sensor 34a, b.

The housing 18 is also advantageous in that undesirable environmental conditions, such as water vapor in the inflowing gas can be expected to affect both reflectors 38a, b similarly. The debilitating effects of the condensation on the respective reflectors can be substantially eliminated by forming a ratio of the outputs from sensors 34a, b.

The fabrication of reflected surfaces 38a, b is not complicated by having to form apertures therein for an inflow of the gas to be sensed. Rather,

the gas to be sensed enters the gas sensor 18 generally parallel to the plane P, and, more or less perpendicular to the direction of transmission of the radiant energy from emitter 32 across the sensing chamber and reference chamber 30a, b.

Figs. 2-7 illustrate further details of the chamber 18. The incident and reflected radiation for sensing and reference purposes R_S, R_R travel substantially the same distances in housing 18. Only a single reflection is required between source 32 and sensors 34a, b as the radiant energy travels through the gas(s) being sensed.

Housing 18 can be molded of a variety of commercially available resins without limitation. The molding process defines the curves of reflectors 38a, b as well as mounting surfaces for emitter 32 and sensors 34a, b. There are no adjustments as none are needed.

From the foregoing, it will be observed that numerous variations and modifications may be effected without departing from the spirit and scope of the invention. It is to be understood that no limitation with respect to the specific apparatus illustrated herein is intended or should be inferred. It is, of course, intended to cover by the appended claims all such modifications as fall within the scope of the claims.